

CLAIMS

What is claimed is:

- 1 1. A method for shaping a surface of a workpiece, comprising:
 - 2 placing the workpiece in a plasma processing chamber including a
 - 3 plasma torch;
 - 4 translating at least one of the workpiece and the plasma torch; and
 - 5 using reactive atom plasma processing to shape the surface of the
 - 6 workpiece with the discharge from the plasma torch.
- 1 2. A method according to claim 1, wherein the step of using reactive
- 2 plasma processing to shape the surface of the workpiece causes minimal
- 3 or no damage to the workpiece underneath the surface.
- 1 3. A method according to claim 1, wherein the step of using reactive
- 2 plasma processing to shape the surface of the workpiece comprises
- 3 removing material from the surface of the workpiece.
- 1 4. A method according to claim 1, further comprising:
 - 2 rotating the workpiece with respect to the plasma torch.
- 1 5. A method according to claim 1, further comprising:
 - 2 creating a reactive species in the plasma.

- 1 6. A method according to claim 1, further comprising:
 - 2 placing a precursor in a central channel of the plasma torch.
- 1 7. A method according to claim 1, further comprising:
 - 2 placing a precursor in the plasma torch and creating a reactive
 - 3 species in the plasma.
- 1 8. A method according to claim 1, further comprising:
 - 2 placing a precursor in the plasma torch.
- 1 9. A method according to claim 1, further comprising:
 - 2 controlling the mass flow of a precursor into the plasma.
- 1 10. A method according to claim 1, further comprising:
 - 2 controlling the mass flow of a precursor into the plasma from
 - 3 between about 0 ml/min to about 2,000 ml/min.
- 1 11. A method according to claim 1, further comprising:
 - 2 controlling the mass flow of a precursor into the plasma from
 - 3 between about 0 ml/min to about 50,000 ml/min.
- 1 12. A method according to claim 1, further comprising:

2 selecting a concentration of precursor to be introduced into a central
3 channel of the plasma.

1 13. A method according to claim 1, further comprising:
2 introducing a plasma gas through an outer tube of the plasma torch.

1 14. A method according to claim 1, further comprising:
2 coupling energy to the discharge in an annular region of the plasma
3 torch.

1 15. A method according to claim 1, further comprising:
2 introducing an auxiliary gas through a second of three concentric
3 tubes in the plasma torch.

1 16. A method according to claim 1, further comprising:
2 using an auxiliary gas to keep hot plasma away from a central
3 channel of the plasma torch.

1 17. A method according to claim 1, further comprising:
2 using an auxiliary gas to adjust the position of a discharge.

1 18. A method according to claim 1, further comprising:
2 controlling the size of a discharge by selecting the inner diameter of

3 an outer tube of the plasma torch.

1 19. A method according to claim 1, further comprising:
2 introducing a plasma gas tangentially.

1 20. A method according to claim 1, further comprising:
2 metering gas flow in the plasma torch.

1 21. A method according to claim 1, further comprising:
2 maintaining the temperature of the plasma between 5,000 and
3 15,000 degrees C.

1 22. A method according to claim 1, further comprising:
2 producing a volatile reaction on the surface of the workpiece.

1 23. A method according to claim 1, further comprising:
2 maintaining the processing chamber at about atmospheric pressure.

1 24. A method according to claim 1, further comprising:
2 cleaning the surface of the workpiece with the plasma.

1 25. A method according to claim 1, further comprising:
2 polishing the surface of the workpiece with the plasma.

- 1 26. A method according to claim 1, further comprising:
 - 2 planarizing the surface of the workpiece with the plasma.
- 1 27. A method according to claim 1, further comprising:
 - 2 using a plasma torch with a multiple head to increase the plasma
 - 3 etch rate.
- 1 28. A method according to claim 1, further comprising:
 - 2 using a precursor solution to control the etch rate of the plasma.
- 1 29. A method according to claim 1, further comprising:
 - 2 using a precursor to control the etch rate of the plasma, the
 - 3 precursor being any one of a solid, liquid, or gas.
- 1 30. A method for cleaning a surface, comprising:
 - 2 placing the workpiece in a plasma processing chamber including a
 - 3 plasma torch;
 - 4 translating at least one of the workpiece and the plasma torch; and
 - 5 using reactive atom plasma processing to remove material from the
 - 6 surface of the workpiece.
- 1 31. A tool for shaping the surface of a workpiece, the tool being able to

2 accomplish the following steps:

3 positioning a workpiece in a plasma processing chamber including

4 a plasma torch;

5 translating at least one of the workpiece and the plasma torch; and

6 using reactive atom plasma processing to shape the surface of the

7 workpiece with the discharge from the plasma torch.

1 32. A tool for shaping the surface of a workpiece, comprising:

2 means for positioning a workpiece in a plasma processing chamber

3 including a plasma torch;

4 means for translating at least one of the workpiece and the plasma

5 torch; and

6 means for using reactive atom plasma processing to shape the

7 surface of the workpiece with the discharge from the plasma torch.

1 33. A tool for shaping the surface of a workpiece, comprising:

2 a plasma torch;

3 a translator that can translate at least one of a workpiece and said

4 torch; and

5 wherein said torch is configured to shape the surface of a workpiece

6 using a reactive plasma process.

1 34. A method for shaping an optic, comprising:

2 placing an optic workpiece in a plasma processing chamber
3 including a plasma torch;

4 translating at least one of the optic workpiece and the plasma torch;
5 and

6 using reactive atom plasma processing to shape the surface of the
7 optic workpiece with the discharge from the plasma torch.

1 35. A method for shaping a high-damage threshold optic, comprising:

2 placing a high-damage threshold optic workpiece in a plasma
3 processing chamber including a plasma torch;

4 translating at least one of the optic workpiece and the plasma torch;
5 and

6 using reactive atom plasma processing to shape the surface of the
7 optic workpiece with the discharge from the plasma torch.

1 36. A method for back-etching a wafer, comprising:

2 placing the a wafer in a plasma processing chamber including a
3 plasma torch;

4 translating at least one of the wafer and the plasma torch; and

5 using reactive atom plasma processing to etch a back surface of the
6 wafer with the discharge from the plasma torch.

1 37. A method for thinning a wafer, comprising:

2 placing the a wafer in a plasma processing chamber including a
3 plasma torch;
4 translating at least one of the wafer and the plasma torch; and
5 using reactive atom plasma processing to remove material from a
6 surface of the wafer with the discharge from the plasma torch.

1 38. A method for thinning bonded wafers, comprising:
2 placing the bonded wafers in a plasma processing chamber
3 including a plasma torch;
4 translating at least one of the bonded wafers and the plasma torch;
5 and
6 using reactive atom plasma processing to remove material from an
7 outer surface of the bonded wafers with the discharge from the plasma
8 torch.

1 39. A method for planarizing a surface of a workpiece, comprising:
2 placing the workpiece in a plasma processing chamber including a
3 plasma torch, the plasma processing chamber at atmospheric pressure;
4 translating at least one of the workpiece and the plasma torch;
5 using reactive atom plasma processing to simultaneously remove
6 material from the surface of the workpiece and redeposit the removed
7 material back onto the surface of the workpiece.

1 40. A method for shaping a surface at atmospheric pressure, comprising:
2 placing the workpiece in a plasma processing chamber including a
3 plasma torch, the plasma processing chamber at atmospheric pressure;
4 translating at least one of the workpiece and the plasma torch; and
5 using reactive atom plasma processing to simultaneously remove
6 material from the surface of the workpiece and redeposit the removed
7 material back onto the surface of the workpiece in order to shape the
8 surface of the workpiece.

1 41. A method for shaping the surface of a workpiece, comprising:
2 positioning a workpiece in a plasma processing chamber including
3 a plasma torch;
4 translating at least one of the workpiece and the plasma torch; and
5 establishing an equilibrium in a plasma reaction in the plasma
6 processing chamber, whereby material may be removed from the surface
7 of the workpiece and redeposited on the surface of the workpiece with the
8 discharge from the plasma torch.